NOISE REMOVAL METHODOLOGIES FOR LUNG CANCER DIAGNOSIS

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NOISE REMOVAL METHODOLOGIES FOR LUNG CANCER DIAGNOSIS

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Thesis submitted in fulfillment of the requirements
for the award of the
Bachelor Degree in Computer Science (Graphic & Multimedia Technology)

Faculty of Computer Systems &Software Engineering

UNIVERSITI MALAYSIA PAHANG

JANUARY 2019

ACKNOWLEDGEMENT

First of all, I would like to thank my supervisor, Dr. Muhammad Nomani Kabir for his expertise, guidance and patience throughout the process of writing the thesis. I am so grateful to have the understanding and supportive supervisor. Without him, it will be impossible to finish this research. I would like to express my sincere gratitude to my family and friends for their endless support and strength in order to finish this project. Last of all, I would like to thank for everyone who involved directly or indirectly and helped me to finish this project successfully.

ABSTRACT

Noise reduction is the one of the step in image processing where the process of reducing noise from an image. The noise present in the images such as in a medical image like Salt and Paper Noise, Gaussian Noise and others. Different noises have their own characteristics which make them identifiable from others. However, enhanced the image especially the medical images is required by doctors to help the diagnosis and interpretation because lack of images quality due to the noise. The methods of noise removal was be analysed from existing paper in literature review. Based on the existing paper, each of the method had their own benefits and drawbacks. Therefore, the uses of suitable method is important to improve the quality of medical image for early diagnosis of lung cancer. In this paper, Gaussian Filter and Median Filter is proposed for removing the noise from CT scan images. The objective of the study is to implement and develop the method of noise removal for lung cancer diagnosis. The development research methodology presented five fundamental stage which are investigation of existing method of noise removal, developing a new method for noise removal, implementation of the noise removal method, verification and validation. Therefore, the algorithm will be developed and implemented in MATLAB software. Then, the method will be tested and verified to detect the cancer in the lung image. The result of CT scan image of lung cancer were showed and to validated the performance of this proposed method.

ABSTRAK

Pengurangan bunyi adalah salah satu langkah dalam pemprosesan imej di mana proses mengurangkan bunyi dari imej. Bunyi yang hadir dalam imej seperti dalam imej perubatan seperti Bunyi dan Saluran Kertas, Bunyi Gaussian, Bunyi Speckle dan Bunyi Berkala. Suara yang berbeza mempunyai ciri-ciri mereka sendiri yang membuat mereka dapat dikenali dari orang lain. Walau bagaimanapun, peningkatan imej terutamanya imej perubatan diperlukan oleh doktor untuk membantu diagnosis dan penafsiran kerana kekurangan kualiti imej disebabkan bunyi bising. Kaedah penyingkiran hingar akan dianalisis dari kertas sedia ada dalam kajian literatur. Berdasarkan kertas sedia ada, setiap kaedah mempunyai manfaat dan kelemahan mereka sendiri. Oleh itu, penggunaan kaedah yang sesuai adalah penting untuk meningkatkan kualiti imej perubatan untuk diagnosis awal kanser paru-paru. Dalam kertas ini, Penapis Gaussian dan Penapis Median dicadangkan untuk mengeluarkan bunyi bising daripada imej imbasan CT. Objektif kajian ini adalah untuk melaksanakan dan membangunkan kaedah penyingkiran hingar untuk diagnosis kanser paru-paru. Metodologi penyelidikan pembangunan membentangkan lima peringkat asas yang menyiasat kaedah penyingkiran hingar yang sedia ada, membangunkan kaedah baru untuk penyingkiran bunyi bising, pelaksanaan kaedah penyingkiran bunyi, pengesahan dan pengesahan. Oleh itu, algoritma akan dibangunkan dan dilaksanakan dalam perisian MATLAB. Kemudian, kaedah itu akan diuji dan disahkan untuk mengesan kanser pada imej paru-paru. Hasil CT scan terhadap kanser paru-paru menunjukkan dan mengesahkan prestasi kaedah yang dicadangkan ini.

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LIST OF ABBREVIATIONS

MATLAB	MATRIX LABORATORY
CT Scan	Computer Tomography Scan
PSMF	Progressive Switching Median Filter
ACWMF	Adaptive Centre Weighted Median Filter
DBA	Decision Based Algorithm
AMF	Adaptive Median Filter
BDND	Boundary Discriminative Noise Detection
FEMF	Fast and Efficient Median Filter
MDBUTMF	Modified Decision Based Unsymmetrical Trimmed Median Filter
SWT	Stationary Wavelet Transform
SSLGD	Soft-Switching Local Graph Denoising
PSNR	Peak Signal-to-Noise Ratio
SSIM	Structural Similarity Index
ANCLPVMF	Adaptive Non-Causal Linear Prediction Based Vector Median Filter
SVM	Support Vector Machine
MHFC	Modified Histogram Based Fuzzy Color
W-SOMP	Weighted-Simultaneous Orthogonal Matching Pursuit
WJSR	Weighted Joint Sparse Representation
MRI	Magnetic Resonance Imaging
MR	Magnetic Resonance
SD	Static or Dynamic

RGB	Red Green Blue
NIR	Near-Infrared
DIC	Differential Interference Contrast
PMRI	Parallel Magnetic Resonance Imaging
SNR	Signal-to-Noise Ratio
AVMF	Adaptive Vector Median Filter
WMF	Weighted Mean Filter

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Lung cancer is one of the deadly sicknesses that principally influence the aspiratory knobs of the lungs. Examination of picture is by and by a basic advance of the lung diseases like analytic, prognostic and development. The survival rate of lung cancer is low when contrasted and every single other kind of growth. The requirement for recognizing lung cancer at a beginning period is extremely basic and is a dynamic research territory in the field of medical image processing. A few Computer supported frameworks have been expected to recognize the lung cancer at the initial stage. Different kinds of images are utilized for detection of lung diagnosis. Madhura & Babu [12] presented the most imperative testing undertaking is discovery of lung nodule. Registered Tomography (CT) pictures are for the most part picked because of less mutilation, low commotion, better clearness, less time utilization and ease. The figure 1 shows the original image of lung cancer in CT scan and figure 2 shows the simulation result of lung CT scan image corrupted with 90 % Salt and Pepper noise (A) Original, (B) Noisy, (C) PSMF, (D) ACWMF, (E) DBA, (F) AMF, (G) BDND, (H) FEMF, (I) MDBUTMF, (J) Proposed.

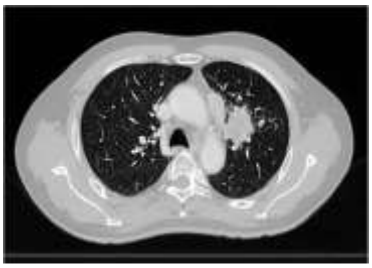


***Figure 1**. CT-scan image.*

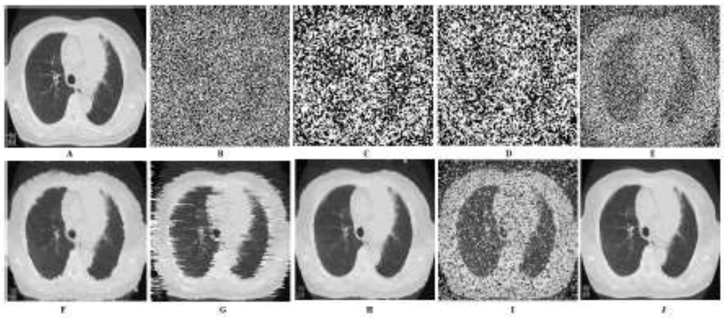


Figure 2. Simulation Results for Lung CT Scan Image Corrupted with 90% Salt and Pepper noise (A) ORIGINAL (B) NOISY (C) PSMF (D) ACWMF (E) DBA (F) AMF (G) BDND (H) FEMF (I) MDBUTMF (J) PROPOSED.

Nowadays, image processing is one of the most growing research areas especially in medical field. Noise removal is the one of the step in image processing where the process of removing noise from a signal. There her are many types of the noise present in the images especially in medical image for the lung cancer diagnosis like salt and paper noise, Gaussian noise, speckle noise and periodic noise. Different noises have their own characteristics which make them identifiable from others. Every medical image have noise that need to be removed to enhance the image and to diagnosis the analysis of image. Therefore, noise can be removed by using noise removal method like minimum filtering, maximum filtering, mean filtering, linear filtering, median filtering and averaging filtering. Noise removal from images is the most active field of research. This research presents the review on the lung cancer, types of noise in medical image and the methods for the noise removal.

1.2 PROBLEM STATEMENT

Noise removal method is uses to enhance the image and help the doctors to detect the cancer earlier before it become worst. The doctors may have a difficulty to interpret the image of cancer because of the noise. Then, enhanced medical images required by surgeons to help the diagnosis and interpretation because lack of images quality due to the noise. So, noise removal method is important for image processing to improve the quality of medical image for early diagnosis. The target due to the enhancement is to solve the problems of the high level noise in medical images. Therefore, we want to solve the problem by using proposed noise removal method from lung cancer image.

1.3 AIM OF OBJECTIVE

1. To study the type of noise removal method from image for lung cancer diagnosis included Gaussian Filter and Median Filter.
2. To develop the combination method of noise removal for lung cancer diagnosis.
3. To evaluate the performance of combination method of noise removal for lung cancer diagnosis.

1.4 SCOPE

This work described the type of noise like Gaussian and salt & pepper. Besides, the combination of noise removal method like Gaussian High Pass Filter and Median Filter was tested. This method was used to enhance the image of lung cancer and helps the doctors and medical department to get the better diagnosis. The algorithm will be implemented in MATLAB. Then, the method will be tested to check their performance by using 20 colour CT Scan images from Cancer Imaging Archive.

1.5 THESIS ORGANIZATION

This thesis consists of three chapters. Chapter 1 was discussed the introduction of the project; chapter 2 was discussed the literature review of this project; chapter 3 was provided the methodology that used in this project; chapter 4 was provided the result and discussion; and chapter 5 was summarized the project report.

CHAPTER 2

LITERATURE REVIEW

2.1 OVERVIEW

This chapter deals with the literature review of the existing project. In this chapter, the noise removal methodologies for lung cancer diagnosis were discussed. Noise removal method is important in image processing to enhance the image and to diagnosis the analysis of image especially in medical field. Besides, the method and classification algorithm with the recent work on the lung cancer diagnosis was analysed. This is to provide information regarding current noise removal method and we list the important method used in table 2.3.

2.2 RELATED WORKS

Noise present in image especially in medical image. Noise removal very important process to enhance and remove noise from the digital image. Based on the existing paper, the methodologies of noise removal was presented.

Gaussian filter is a linear filter that most performs filter to remove the noise by smoothing and sharpening. Gaussian smoothing is very effective for removing Gaussian noise. Gaussian sharpening is very effective for detecting the edges or define details. The Gaussian High Pass filter allows high frequency image information to pass through and blocks low frequency image information. It effectively for sharpens and detecting the edge. In contrast, the Gaussian filter is a low pass filter that allows low frequency image information to pass through and blocks high frequency image information. It effectively for blurring or smoothing the image.

The Median filter is a non-linear filter that is most used to reduce noise in an image. It is very effective at removing noise while preserving edges. It is particularly effective at removing salt and pepper noise. The median filter works by moving through the image pixel by pixel, replacing each value with the median value of neighbouring pixels. The pattern of neighbours is called the window, which slides, pixel by pixel, over the entire image. The median is calculated by first sorting all the pixel values from the window into numerical order, and then replacing the pixel being considered with the middle median pixel value.

Guo et al. [1] discussed the stationary wavelet transform (SWT) based method is proposed to de-noise the digital image with the light noise and the SWT de-noise algorithm is presented after the analysing of the light noise. The outcome show that the de-noise technique can be connected to the full-field strain estimation under the light obstruction with a high precision and steadiness.

Zhang et al. [2] presented the decision-based on local means filter method for removing impulse noise from digital images. In their study, it recognizes the undermined pixels utilizing the neighbourhood insights based noise indicator and afterward expels the identified driving forces utilizing the reference picture based non nearby means filter while keeping the uncorrupted pixels unaltered.

Pérez-Benito et al. [3] discussed a model based on local graphs for colour images and its application for Gaussian noise smoothing. In their study, they have designed a hybrid filter for colour image smoothing. It combines a filter ready to legitimately process level picture areas with another that is more fitting for points of interest and texture. As the result, performance of the new proposed method, SSLGD, in terms of PSNR, SSIM and demonstrates that it is focused as for best in class strategies, diminishing the computational unpredictability because of the worldwide portrayal of the parameters, which enables us to lessen the computational cost.

Su et al. [4] presented relative reductive structure-aware regression filter technique. In their study, this technique is to cure the restriction of current edge-protecting smoothing filter for removing the noticeable structures. This strategy likewise built on bit relapse with a structure-part descriptor. As the result, a slight edge obscure still exists in the pictures with solid unpredictable surfaces. In addition, the separated yield does not have a decided quality assessment standard.

Roy & Laskar [5] discussed the non-casual linear prediction based adaptive filter for removal of high density impulse noise from colour images. In their study, an image is influenced by high thickness of impulse noise, homogeneity among the pixels is contorted. In the proposed method, if the pixel under task is observed to be tainted, the sifting activity will be completed. The choice about a specific pixel of being debased or not relies upon the direct forecast mistake ascertained from the non-causal area around the pixel under task. The ANCLPVMF based method gives acceptable execution to low density noise.

Roy & Laskar [6] presented the multiclass SVM based adaptive filter for removal of high density impulse noise from colour images. In their study, the technique have been assessed using peak signal to noise ratio (PSNR) and structural similarity index measure (SSIM). the technique have been assessed that for fixed valued impulse noise, the proposed filter performs better than the MHFC if there should be an occurrence of high density impulse noise (>45%). This technique combines the benefit of both multiclass SVM and adaptive vector median filtering.

Liu et al. [7] discussed the weighted joint sparse representation for removing mixed noise in image. In their study, they present a greedy algorithm called weighted simultaneous orthogonal coordinating interest to effectively inexact the worldwide ideal arrangement. However, motivated by the greedy algorithm, they presented a W-SOMP algorithm to explain the proposed WJSR model by approximating the worldwide ideal arrangement and the outcome that they proposed de-noising technique accomplished better execution in expelling mixed noise than best in class strategies.

Pieciak et al. [8] presented the non-stationary Rician noise estimation in parallel MRI using a single image. In their study, they propose a new automatic noise estimation technique for non-stationary Rician noise that overcomes the previously mentioned disadvantages. Their estimation approach fills in as an underlying period of further MR picture preparing pipeline as could be picture de-noising in the MRI field requiring a gauge of the variation noise.

Ham et al. [9] discussed a robust guided image filtering using no convex potentials. In their study, they use the guided or joint image filtering method and propose a SD (for static or dynamic) filter to tackle the issue in a unified framework. This paper investigate a few properties of the SD filter including scale change, runtime, separating conduct and its association with different filter. Probing this filtering technique, they apply the SD channel to profundity up testing, scale-space sifting, surface evacuation, streak or non-streak de-noising, and RGB or NIR de-noising. The outcomes been acquired from source codes gave by the creators, and every one of the parameters for all contrasted techniques have been experimentally set with yield the best normal execution through broad analyses.

Sadreazami et al. [10] presented iterative graph-based filtering for image abstraction and stylization to perform iterative filtering without requiring any weight updates. In their study, it make use of the graph Laplacian matrix acquired from the comparability grid to upgrade the smoothened yield of each layer. A set of colour images was be tested and the consequence of this technique can create multi-layer preoccupied pictures while holding a significant part of the perceptually imperative data.

Roy et al. [11] discussed the combination of adaptive vector median filter and weighted mean filter for removal of high density impulse noise from colour images. In their study, the examinations have been done on a substantial database for various classes of pictures, and the execution is estimated in terms of peak signal-to-noise ratio, mean squared error, structural similarity and feature similarity index. The outcome demonstrates that the proposed filter gives enhanced execution to settled esteemed impulse noise as well as for arbitrary esteemed impulse noise irrespective of noise densities.

2.3 DISCUSSION

Table 2.3. Summary of Existing Papers.

Author	**Method**	**Features**	**Advantages**	**Drawback**	**Test dataset**
1. Guo et al. [1]	Stationary wavelet transform (SWT)	Capable of providing accurate DIC measurements in the light noise environment.	Simple, easy to implement, and effective light noise suppressed algorithm.	The precision and stability of the DIC measurement could be upgraded.	Parallel light
2. Zhang et al. [2]	Decision-based non local means filter	Remove impulse noise from the corrupted images effectively restoration performance	Restoration performance among the proposed filter and numerous switching-based techniques.	Filters are for the most part the point-wise filters which attenuate the impact of impulse	Real image like TV image and the panora-mic radio-graph

				noise by averaging the pixels in a similar structure.	
3. Pérez-Benito et al. [3]	Soft-Switching Local Graph Denoising (SSLGD)	Provide a characteriza-tion of each pixel based on the link cardinality of its connected component.	The filter is very easy to use.	Aggressive regarding cutting edge strategies, diminishing the computation-nal complexity	Original colour image
4. Su et al. [4]	Structure aware filter via bilateral kernel regression	Removing structure from picture while saving sharp edges and smoothing satisfactorily.	Better performance and improve the quality of image decompose-tion	The slight edge blur exists and lacks a determined quality evaluation standard.	Original input image
5. Roy & Laskar [5]	Non-casual linear prediction based adaptive filter	Satisfactory performance for low density noise.	Improved performance for removal of impulse noise.	Image is little bit blurred for high density of noise.	Colour images like Lena, Mandrill, Miramar etc. and biomedi-cal images like

					tissues, microor-ganisms, kidney etc.
6. Roy & Laskar [6]	Multiclass SVM based adaptive filter	Effective for removal of impulse noise of higher density.	Detect and remove high density impulse noise from colour images	Blurring effect may occur	Colour images
7. Liu et al. [7]	Weighted joint sparse representation (WJSR)	Powerful tool to deal with various image processing and computer vision tasks,	Better performance in removing mixed noise than state-of-the-art methods	Comparable patches share likenesses yet in addition have contrasts in sparse coding	Colour images
8. Pieciak et al. [8]	Parallel magnetic resonance imaging (PMRI) technique	The stabilization process and the homemorphic estimation eliminate the granularity, reduce the under or overestimatio	Better performance for the whole range of signal-to-noise ratio (SNR)	The technique works for various MR modalities and only one single picture without background or	Synthetic and real MRI datasets

		n of noise and lead to more reliable estimates.		foreground region extraction is required.	
9. Ham et al. [9]	Guided or joint image filtering.	The flexibility and effectiveness of the proposed SD (for static or dynamic) filter in a variety of applications	Controls picture structures at various scales and deal with an assortment of sorts of information from various sensors and great edge-protecting properties	Data dependent framework are not think about basic contrasts amongst direction and input image, and that it is powerful to outliers	The images of adjacency
10. Sadreazami et al. [10]	Iterative graph-based filtering.	Capable of simultaneous-ly manipulating and enhancing fine details in the image.	Improve the visual quality for stylized images.	Stylization effect has been generated in the output image.	Colour images
11. Roy et al. [11]	Combination of adaptive vector median	Potential to offer equivalent execution all through the	Better performance at low density of impulse noise	Fuzzy decision based rule for grouping of	Berkeley image segmenta-tion dataset

	filter (AVMF) and weighted mean filter (WMF).	differed noise densities can be considered as another option to the current filter.	yet in addition gives satisfactory performance at high density.	uproarious and non-loud pixels might be investigated.	(human subjects) such as Tower, Water-fall, Landforms etc. and satellite images.

Table 2.3 was the summary of existing method. In the first column was provided the name of authors of the paper, second column was the method that was used in the paper, third column was the features of the method in the paper, fourth column present in advantages of the method, fifth column present the drawback of method in the paper and the last column was a task dataset used by the author was listed.

CHAPTER 3

METHODOLOGY

3.1 OVERVIEW

This chapter was discussed on the research methodology to develop the combination of algorithm for noise removal. The discussion start with the methodology where it covers the investigation of existing method of noise removal then we develop a new method and implement the method in MATLAB. After that, check and test the program for validation. This chapter also include the discussion of hardware and software that used in experiments. Figure 3.1 shows that the level in the research methodology.

3.2 METHODOLOGY

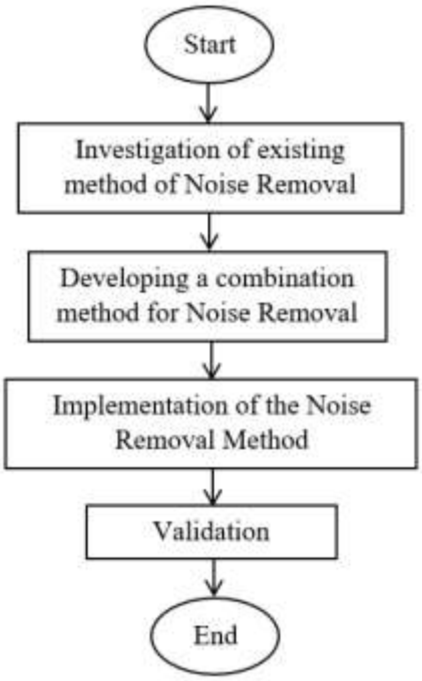


Figure 3.1 Flowchart of Development Research Methodology.

3.2.1 Investigation of existing method of Noise Removal

The first stage is literature review to investigate and analysis the existing method of noise removal from research papers in chapter 2. In the research papers, the technique of noise removal has been proposed with different methods such as Stationary Wavelet Transform (SWT), Weighted Joint Sparse Representation (WJSR), Parallel Magnetic Resonance Imaging (PMRI) technique, Iterative Graph-Based Filtering, Guided or Joint Image Filtering, Structure Aware Filter via bilateral kernel regression and others. The analysis between methods has been presented in Chapter 2.

3.2.2 Developing a combination method for Noise Removal

In the next stage, a combination method of noise removal for lung cancer diagnosis will developed. This depends on the acceptable method that will enhance the image and get better diagnosis of lung cancer. Furthermore, this method will be intended to accomplish better performance and result compare to other existing works. Figure 3.2 shows the proposed flowchart for developing a combination method.

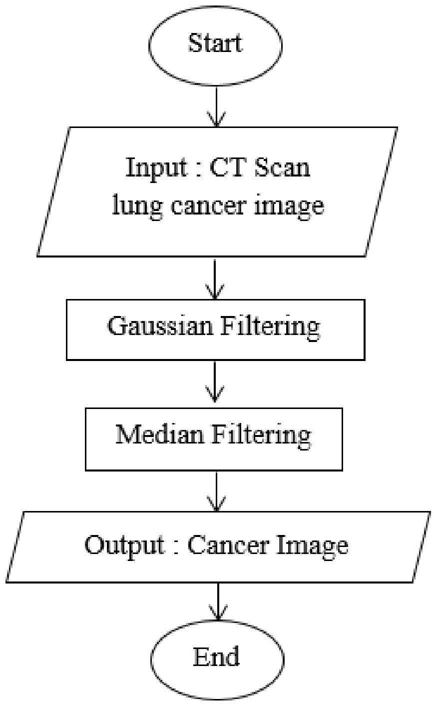


Figure 3.2 Proposed Flowchart of Development.

However, we uses the Gaussian Filter for enhancing an image. In this way, we use the high pass filter for sharpening an image and obtain fine details of an image including detect an edge. Gaussian High Pass Filter is defined as:

$$H(m,n) = 1 - e^{-D^2(m,n)/2{D_0}^2}$$

Then, we uses Median Filter to reduce noise by filtering the noise from high pass filter while preserving the edges. It also be used for reducing impulse noise such as Salt and Pepper noise. Median Filter is defined as:

$$y[m,n] = median\{x[i,j],(i,j) \in w\}$$

Below shows the algorithm for the proposed method, the combination of noise removal method which is Gaussian High Pass Filter and Median Filter.

```
INPUT: CT Scan Image
Perform Gaussian High Pass Filtering as follows
for i = 1:m
        for j = 1:n
                If (D^2[i] < D^2[ii]
                {
                  H=1- e^(-((D^2[i]+D^2[j])/2D_0^2))
                }
        end (for)
end (for)
Perform Median Filtering as follows
for i = 1:m
        for j = 1:n
                If (x[i] < x[j]
                {
                 w = x[i]; x[i] = x[j]; x[j] = w;
                }
        end (for)
end (for)
OUTPUT: Enhance CT Scan Image
```

3.2.3 Implementation of the Noise Removal Method

This method will be implemented using MATLAB software. In this stage, the lung image of CT scan will be used. The MATLAB software is easy to use and most suitable software for the implementation of the noise removal method.

3.2.4 Validation

In the last stage of research methodology, validation is the process to check and test the algorithm or method to guarantee that the determination and the output of implementation of noise removal method is right. The original of lung images are analysed by specialists for analysis and discovery of lung cancer. This method must free error to give better result and performance.

3.3 SOFTWARE AND HARDWARE SPECIFICATIONS

Table 3.3(a) and table 3.3(b) shows the hardware and software specifications during the research process and the development and implementation of new noise removal method process.

HARDWARE	SPECIFICATION
Laptop HP Pavilion 14 Notebook	Intel® Core™ i5-7200U CPU @ 2.50GHz 2.71GHz Windows 10

TABLE 3.3(a): Hardware Specifications

SOFTWARE	SPECIFICATION
MATLAB Software	Used in an implementation the new method.
Microsoft Office Words 2013	Used in writing documentations along this research.
Microsoft Office Presentation 2013	Used in preparation slide before the presentation.
Microsoft Office Excel 2013	Used in design the Gantt Chart.

TABLE 3.3(b): Software Specifications

3.4 GANTT CHART

The Gantt chart shows the tasks scheduled of the timeline and milestones of the research. Refer to Appendix 3.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter was explained on the implementation of the algorithm and methodology to develop the combination of algorithm for noise removal. The discussion start with experiments the methods of noise removal. Then, we develop a combination method and implement the method in MATLAB. After that, test and verify the result for validation. This chapter also discussed the result obtained from the proposed method for the lung cancer analysis.

4.2 RESULT DISCUSSION

This algorithm was implemented in MATLAB. The result obtain from the experiment in using two types of noise removal which are Salt and Pepper Noise for the example of high level noise and Gaussian Noise for the low to medium level noise. In this experiment, the CT scan images of lung cancer was be used to test the algorithm. The experiment started when the CT scan images was applied with the noise. Due to the some requirement, the doctors need to analysis the images using other machines and the high level noise may occurred. That why the noise was added to check the performance of algorithm. Then, Gaussian High Pass Filter was added and the edges and details was highlighted. Thus, the noise was not completely removed. After that, the Median Filter was applied to reduce the noise without effecting the edges or details in images.

In order to verify the effectiveness of the proposed method, the CT scan image was applied with the types of noise like Salt and Pepper Noise, Gaussian Noise. The figure shows that the dataset of CT scan image with types of noise.

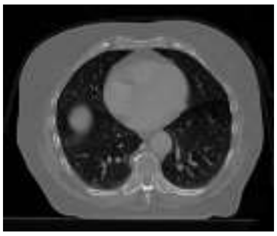
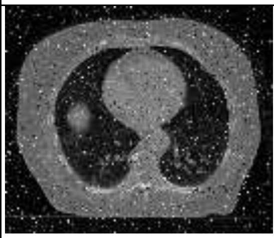
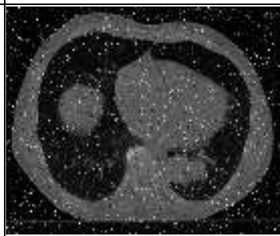
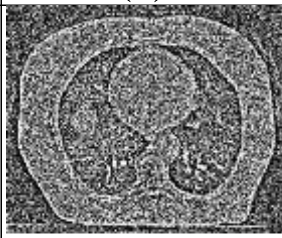
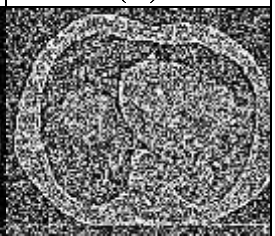
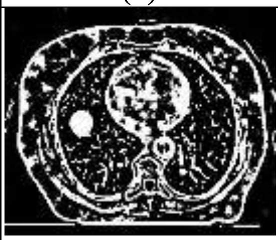
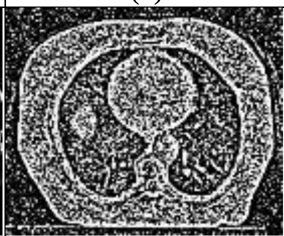
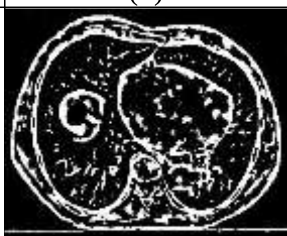
	Image 4(a)		Image 4(b)	
CT Scan Image				
Noise	Salt & Pepper noise	Gaussian Noise	Salt & Pepper noise	Gaussian Noise
Noise was added	 (i)	 (iv)	 (i)	 (iv)
Perform Gaussian High Pass Filter	 (ii)	 (v)	 (ii)	 (v)
Perform Median Filter	 (iii)	 (vi)	 (iii)	 (vi)

Figure 4(a) and 4(b) : original image, (i) With Salt and Pepper Noise, (ii) Gaussian High Pass Filter, (iii) Median Filter, (iv) With Gaussian Noise, (v) Gaussian High Pass Filter, (vi) Median Filter

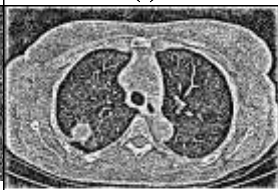
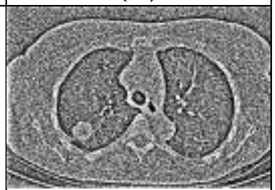
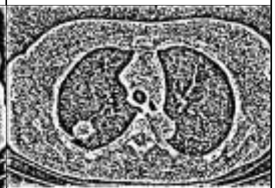
	Image 4(c)		**Image 4(d)**	
CT Scan Image				
Noise	Salt & Pepper noise	Gaussian Noise	Salt & Pepper noise	Gaussian Noise
Noise was added	 (i)	 (iv)	 (i)	 (iv)
Perform Gaussia n High Pass Filter	 (ii)	 (v)	 (ii)	 (v)
Perform Median Filter	 (iii)	 (vi)	 (iii)	 (vi)

Figure 4(c) and 4(d) : original image, (i) With Salt and Pepper Noise, (ii) Gaussian High Pass Filter, (iii) Median Filter, (iv) With Gaussian Noise, (v) Gaussian High Pass Filter, (vi) Median Filter

CHAPTER 5

CONCLUSION

5.1 SUMMARY

Noise reduction is the one of the important step in image processing where it removes noise from the image. Noise removal method can enhance medical images required by doctors for better diagnosis and interpretation because lack of images quality due to the noise. In this paper, noise removal method from CT scan image for lung cancer diagnosis have been elaborated. The proposed solution is the combination method of noise removal for lung cancer diagnosis which are Gaussian High Pass Filter and Median Filter. This method shows the better result for the lung cancer diagnosis which have a Salt and Pepper noise in the image. Meanwhile, it shows the satisfaction result for the other CT scan image with the other noise like Gaussian. This experiment used CT-scan images to test and verify the combination method of noise removal.

5.2 FUTURE WORK

The future work for this research can be done by improving the algorithm of noise removal method for lung cancer analysis. This algorithm may give a better lung cancer diagnosis that can be used by doctor and medical experts. In addition, expand the algorithm to give the better analysis result for other types of noise.

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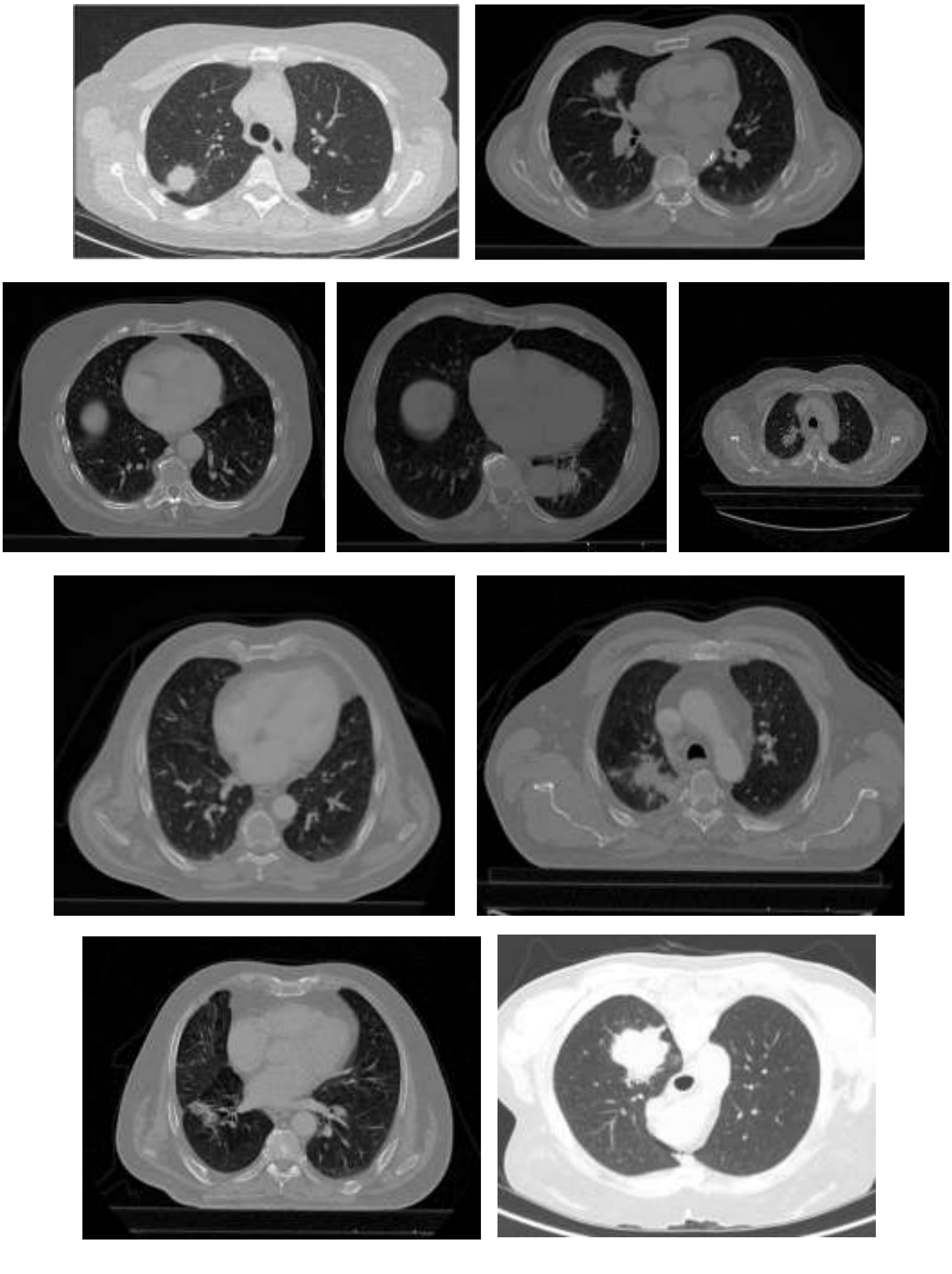
APPENDICES

APPENDIX 1

CT scan image from database



APPENDIX 2

Matlab code

PSM.m

```
I = imread('image8.png');
I = rgb2gray(I);
figure
imshow(I); title ('Original Image');

%%%type of noise%%%
J = imnoise(I,'salt & pepper');
J = imnoise(I,'gaussian');
figure
imshow(J); title ('Noise Image');

%%%noise removal method%%%

%%gaussian high pass%%
PQ = paddedsize(size(J));
D0 = 0.05*PQ(1);
H = hpfilter('gaussian', PQ(1), PQ(2), D0); % Calculate the HPF
F=fft2(double(J),size(H,1),size(H,2)); % Calculate the discrete
Fourier transform of the image
HPF_J=real(ifft2(H.*F)); % multiply the Fourier spectrum by the LPF
and apply the inverse, discrete Fourier transform
HPF_J=HPF_J(1:size(J,1), 1:size(J,2)); % Resize the image to undo
padding
figure
imshow(HPF_J); title ('Gaussian High Pass Filter');

%%median filter%%
K = medfilt2(HPF_J);
figure
imshow(K); title ('Median Filter');
```

APPENDIX 3

Gantt Chart